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<b>4. TITLE AND SUBTITLE</b>  Nondestructive Inspection (NDI) Facility Radiation Protection Survey for Homestead ARB, FL				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Maj Zahid Sulaiman, TSgt Samuel Ortiz, SSgt Michael Ames				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
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<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> USAF School of Aerospace Medicine Occupational and Environmental Health Dept/OECM 2510 Fifth St. Wright-Patterson AFB, OH 45433-7913				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFRL-SA-WP-CL-2012-0064	
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<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> A radiation protection survey of the shielded NDI facility at Homestead ARB was conducted. The NDI facility used a Lorad LPX-160 x-ray unit for inspections. In addition, a survey of the Class IIIa lasers was included in the assessment. The survey was performed in accordance with T.O. 33B-1-1 and applicable Air Force standards. The NDI facility was recertified as a "Shielded Facility."					
<b>15. SUBJECT TERMS</b> NDI, shielded facility, x-ray survey, LASER, Lorad, LPX-160, Homestead ARB					
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<b>a. REPORT</b> U	<b>b. ABSTRACT</b> U	<b>c. THIS PAGE</b> U			TSgt Samuel Ortiz
			SAR	23	<b>19b. TELEPHONE NUMBER (include area code)</b>



**DEPARTMENT OF THE AIR FORCE**  
**USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)**  
**WRIGHT-PATTERSON AFB OH**

31 October 2012

MEMORANDUM FOR 482 MSG/SGPB

ATTN: MR. MICHAEL SCHMIDT  
29050 Coral Sea Blvd, Box 16  
Homestead ARB, FL 33039-1299

FROM: USAFSAM/OECM

2510 Fifth St  
Wright-Patterson AFB, OH 45433-7913

SUBJECT: Consultative Letter AFRL-SA-WP-CL-2012-0064, Nondestructive Inspection (NDI) Facility Radiation Protection Survey for Homestead ARB, FL

1. INTRODUCTION: At the request of 482 MSG/SGPB, the Radiation Health Consulting section of the United States Air Force School of Aerospace Medicine (USAFSAM) completed a radiation protection survey of the shielded exposure room of the 482 MXS/MXMFN NDI laboratory on 6 Jun 12. In addition, USAFSAM identified and classified the laser accompanying the x-ray units.

a. *Scope:* The purpose of this survey was to reevaluate the NDI shielded x-ray facility for compliance with T.O. 33B-1-I, Chapter 6, *Radiographic Inspection Method*, and compliance with occupational and general public radiation safety standards. Specifically, this survey included a review of worker radiation dosimetry records, Bioenvironmental Engineering's occupational safety records, NDI's operating procedures/instructions, radiation safety training, and facility design documents.

b. *Survey Personnel:*

- (1) Maj Zahid Sulaiman, Health Physics Consultant, USAFSAM/OECM
- (2) TSgt Samuel Ortiz, Radiation Health Consultant, USAFSAM/OECM
- (3) SSgt Michael Ames, Radiation Health Consultant, USAFSAM/OECM

c. *Personnel Contacted:*

- (1) Mr. Michael Schmidt, Installation Radiation Safety Officer (IRSO), 482 MSG/SGPB
- (2) SMSgt Carlos Grigsby, NDI Lab Supervisor, 482 MXS/MXMFN

d. *Equipment:*

- (1) Fluke Biomedical – 451P (serial number 210)
- (2) Fluke Biomedical – 451P (serial number 212)
- (3) Fluke Biomedical – 451P (serial number 6573)

## 2. SURVEY PROCEDURES/DISCUSSION:

a. *General Radiation Safety and Facility Design:* A summary of general radiation safety findings and comments is provided below, with detailed information contained in Attachments 1-6.

- (1) Established NDI safety procedures meet T.O. 33B-1-1 and other occupational safety and health requirements. The IRSO must be notified when safety procedures are changed.
- (2) An adequate number of radiation survey instruments and personal monitoring devices were available and operational.
- (3) All exposure room doors have safety interlocks as required by T.O. 33B-1-1. In addition, all warning lights and audible signals were also found to be operating properly.
- (4) The team inventoried and characterized two Lorad Class IIIa alignment lasers (S/N: 0295 and 0330) that are used in conjunction with the Lorad LPX-160 x-ray unit. These Class IIIa alignment lasers have a nominal ocular hazard distance (NOHD) of 35 meters. Personnel within this distance have the potential to experience eye damage. Although laser eye protection use is optional, the operator must treat the laser pointer as a dangerous tool and not direct the laser beam towards any other person. Training and control of these devices should be implemented. For further information, please see Attachment 5. We independently verified the NOHD calculation for Lorad lasers using Laser Hazard Analysis (LHAZ) software; the result is shown in Attachment 6.

b. *Radiation Survey* (see Attachment 1): Radiation measurements were made outside all exterior walls of the exposure room to include the rooftop (see Attachment 2). The tubehead was directed at the floor in the exposure room to characterize current/past operations. Measurements were made with the x-ray tube (Lorad LPX-160) directed at the floor because this is their normal operating procedure. The x-ray tubehead settings were set at 160 kVp and 5 mA for all measurements. The radiation protection survey verifies that the lead shielding is more than adequate for projected NDI operations and shows compliance with the occupational dose limit of 5 rem/yr and general public radiation dose limit of 100 mrem/yr. The NDI exposure room in building 180 is hereby recertified as a “**shielded facility**” for conducting nondestructive inspections. Attachment 3 contains a complete listing of survey results and calculated radiation dose estimates.

c. *References:* The following references were used for our survey:

- (1) Technical Order 33B-1-1, *Nondestructive Inspection Methods*
- (2) Air Force Manual 48-125, *Personnel Ionizing Radiation Dosimetry*
- (3) Air Force Occupational Safety and Health Standard 48-139, *Laser Radiation Protection Program*
- (4) Air Force Instruction 48-148, *Ionizing Radiation Protection*
- (5) ANSI N43.3-2008, *American National Standard for General Radiation Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up To 10 MeV*

(6) ANSI Z136.1, *American National Standard for Safe Use of Lasers*

3. RECOMMENDATIONS: Overall, the NDI laboratory has a program in place that will keep exposures as low as reasonably achievable (ALARA). Based on observations, USAFSAM recommends the following:

- a. The Bioenvironmental Engineering (BE) Office and NDI laboratory continue a close working relationship.
- b. Continue training on instruments from the BE office that are capable of measuring 2 mrem/hr to 1 rem/hr.
- c. Ensure documentation on AFTO IMT 140 of timeframes when NDI equipment is at PMEL.
- d. Perform EPD audible alarm check prior to each work day. The EPD should be programmed to run a "Test" from the LCD display. This "Test" will allow the EPD to cycle through an EPD confidence test that checks the alarms.
- e. It was identified during the survey that the exposure room was used as a storage room. To keep exposures ALARA, use the exposure room only for NDI operations.

4. SMSgt Grigsby, MSgt Hansen, TSgt Sarabia, SSgt Farley, and Mr. Schmidt were extremely helpful in the performance of this survey, and our office thanks them for their assistance. The unshielded facility was not surveyed during this visit, since the facility was under construction. If you have any questions or need further information, please contact my POC, TSgt Samuel Ortiz, at DSN 798-3410, or e-mail at [samuel.ortiz@wpafb.af.mil](mailto:samuel.ortiz@wpafb.af.mil).



ZAHID M. SULAIMAN, Maj, USAF, BSC  
Health Physics Consultant

Attachments:

1. NDI Survey Form
2. Diagram of Building 180 with Survey Locations
3. Survey Measurements and Dose Estimates
4. USAFSAM 451P Calibration Certificates (S/N: 210; 212 and 6573)
5. AFMSA/SGPR, Lorad Laser Pointer Device Requirements
6. Laser Hazard Analysis (LHAZ) Report

## ATTACHMENT 1

### NONDESTRUCTIVE INSPECTION SURVEY FORM

Survey Date: 6 June 2012

#### I. FACILITY IDENTIFICATION:

A. Base: Homestead ARB

B. Bldg Number: 180

C. State/Country: FL, USA

D. Room Number: 123 (Exposure Room)

E. Command: AFRC

F. Phone Number (DSN): 535-7350

G. Organization: 482 MXS/MXMFN

H. WPI: 0088-FAND-404A

#### II. MONITORING INSTRUMENTS:

YES NO N/A

- |  |                                     |                                     |                          |
|--|-------------------------------------|-------------------------------------|--------------------------|
| 1. Adequate number of instruments on-hand (T.O. 33B-1-1, 6.8.5.8.6.2)                        | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> |
| a. Instrument turned on and available during radiographic operations                         | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> |
| 2. Instruments calibrated in accordance with T.O. 33K-1-100-WA-1 (T.O. 33B-1-1, 6.8.5.8.5.2) | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> |
| 3. Instruments checked before use with radiation check source (T.O. 33B-1-1, 6.8.5.8.5.1)    | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> |
| a. Source checked every 2 weeks if not in daily use  | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> |
| b. Battery and source checks annotated on AFTO IMT 140                                       | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> |
| 4. Instruments capable of measuring 2 mrem/hr through 1 rem/hr (T.O. 33B-1-1, 6.8.5.8.2)     | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | <input type="checkbox"/> |

**Table 1. Equipment List**

Manufacturer	Model	Serial Number	Calibration Date	Calibration Interval	Operational?	
					Y	N
Nuclear Research Corporation	SM400	583-0598	29 Feb 12	180 days	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Nuclear Research Corporation	SM400	489-0172	PMEL	180 days	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Nuclear Research Corporation	SM400	489-0338	29 Feb 12	180 days	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Nuclear Research Corporation	SM400	583-0412	22 Nov 11	180 days	<input checked="" type="checkbox"/>	<input type="checkbox"/>

**Comments:** Although the SM-400 is not capable of a range of 2 mrem/hr to 1 rem/hr, the Bioenvironmental Engineering office has a 451P and/or RO-2 ion chamber available for use, and the NDI shop has been trained on the instruments. Recommend that NDI personnel continue to receive training from the BE office on an instrument capable of that range of detection. In addition, we recommend that the NDI shop annotate times when the SM-400s are turned into PMEL on the AFTO IMT 140.

### III. EQUIPMENT IDENTIFICATION:

**Table 2. Description of Console and X-Ray Tube**

Manufacturer / Model Number	Serial Number	kVp	mA	Tube Output	Tubehead
LORAD / LPX-160	CO496425 (Console)	160	5	1.367 mR/sec @ 1 m	Standard 40 deg
	X0496428 (X-Ray Tube)				
LORAD / LPX-160	CO496446 (Console)	160	5	N/A	Standard 40 deg
	X0496449 (X-Ray Tube)				

**Comments:** Tube output was calculated using the 451P (S/N 6573) using integrate mode during a 10-minute exposure. Dose rate was converted to mR/sec to input into the Defense Occupational and Environmental Health Readiness System (DOEHRS). Console (CO496425) was used for the shielded survey. The NDI shop has an additional unit (CO496446) that can be used for operations.

### IV. DOSE ASSESSMENT AND PERSONNEL MONITORING:

**YES NO N/A**

- A. Persons adequately monitored (10 CFR 20.1502; T.O. 33B-1-1, 6.8.5.3) ☒ ☐ ☐
- B. Thermoluminescent device available ☒ ☐ ☐
1. One per radiographer ☒ ☐ ☐
  2. Worn during radiography ☒ ☐ ☐
  3. TLDs properly stored (AFMAN 48-125; T.O. 33B-1-1, 6.8.5.4.4) ☒ ☐ ☐
  4. TLDs returned to storage rack at the end of the work day ☒ ☐ ☐
  5. TLD exchange frequency: Quarterly ☐ ☐ ☐
  6. TLD review period: Quarterly ☐ ☐ ☐
- C. Pocket ionization chamber (PIC) or electronic personal dosimeter (EPD) available ☒ ☐ ☐
1. Proper central storage location for PIC/EPDs and control ☒ ☐ ☐
  2. Date of last usage: 22 May 12
  3. Quantity of dosimeters on-hand: 4
  - Quantity at PMEL: 0
  4. Sufficient number on-hand ☒ ☐ ☐
  5. Worn during radiography ☒ ☐ ☐
  6. Calibration interval: Annual ☐ ☐ ☐
  - Calibration of all on-hand current ☒ ☐ ☐
  7. All function properly ☒ ☐ ☐
  8. EPD audible alarm checked prior to each work day ☐ ☒ ☐
  9. EPD audible alarm set at dose <500 mR? ☒ ☐ ☐
  10. Utilization log available (T.O. 33B-1-1, 6.3.10.2.1) ☒ ☐ ☐
  11. Readings recorded daily (Unshielded Operations) ☒ ☐ ☐
  - Date of last entry: 25 Mar 12
  12. Real-time dosimeter log maintained for 3 years ☒ ☐ ☐
  13. Exposures within limits (10 CFR 20.120; T.O. 33B-1-1, 6.8.5.2.1.1) ☒ ☐ ☐
  14. Prior cumulative occupational doses obtained/attempted (10 CFR 20.2104) ☒ ☐ ☐
  15. Exposure data supplied to workers annually (10 CFR 19.13) ☒ ☐ ☐

**Table 3. Dosimeter Listing**

Manufacturer	Model Number	Serial Number	Calibration Date
Thermo	EPD 2.3	126497	7 Dec 11
Thermo	EPD 2.3	126504	7 Dec 11
Thermo	EPD 2.3	126492	7 Dec 11
Thermo	EPD 2.3	126955	7 Dec 11

**Comments:** Separate logbooks are used for shielded and unshielded operations. Each time an unshielded operation took place, an EPD was issued. EPDs have also been utilized for shielded operations. AFTO IMT 115 is used to document the issue of EPDs. It was identified that the EPD alarm was not checked prior to issue. To perform a check of the alarm, the EPD should be programmed to run a “Test” from the LCD display. This “Test” will allow the EPD unit to cycle through an EPD Confidence Test that checks the alarms. PICs are no longer used for NDI operations.

**V. EXPOSURE AREA DESCRIPTION:**

A. Dedicated Exposure Room: YES ☒ NO ☐

1. Construction

- a. Construction Date: January 1997
- b. Design Criteria: (kVp: 160); (mA: 5); (Workload: 0.5 hr/wk)
- c. Dimensions (ft): (Length: 30); (Width: 18.6); (Height: 18)

**Table 4. NDI X-Ray Vault Shielding**

Location / Description	Shielding Type		Min Distance to Tubehead	Occupancy Factor	Use Factor	Shielding Verified?
North Wall / Rm 121 (Dark Room)	Lead	1/8 inch	15.2 ft	1	0	Yes
North Wall / Rm 122 (Control Panel)	Lead	1/8 inch	16.25 ft	1	0	Yes
South Wall / Outside	Lead	1/8 inch	14.3 ft	0.025	0	Yes
East Wall / Rm 124 (Penetrant Mag Particle Bay)	Lead	1/8 inch	8.4 ft	1	0	Yes
West Wall / Outside	Lead	1/8 inch	10.25 ft	0.025	0	Yes
Ceiling / Outside	None	N/A	15 ft	0.025	0	No
Floor / Ground	Concrete	5 inch	3 ft	0	1	N/A

2. Facility diagram with survey locations (not to scale): See Attachment 2

**B. Facility Requirements:**

- 1. Installation inspected each day facility used (T.O. 33B-1-1, 6.8.8.1.c)
  - a. AFTO Form 135 utilized
  - b. Audible Warnings
  - c. Visible Warnings
  - d. Interlocks

YES	NO	N/A
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

e. Delay Switches	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Emergency Shut-Off (ESO) Switches	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Doses in controlled areas and environments meet general public limits (T.O. 33B-1-1, 6.8.8.1.a)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Suitable means of exit when doors are closed (T.O. 33B-1-1, 6.8.9.10)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Exposure room uncluttered and not used for excessive storage (T.O. 33B-1-1, 6.8.7.2.1.3)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5. Exposure room equipped with			
a. Audible Warning Signal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Ceases when exposure is started	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ii. Activated at least 20 sec prior to exposure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Visible Signal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Inside Exposure Room Type and Color: <u>Red Rotating Beacon</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ii. Outside Exposure Room Type and Color: <u>Red Rotating Beacon</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iii. Activated at least 20 sec prior to exposure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iv. Remain actuated during exposure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Pre-Start switch located inside enclosure and operational. Not required if tubehead is de-energized when interlock is tripped, and tubehead cannot be re-energized by merely closing interlock; interlock system must be re-initiated at control panel.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. Type: <u>Red Rotating Beacon</u>			
b. Pre-Start activated before first exposure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Reset required if interlocked tripped	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Reset required if ESO pressed	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Functions properly	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Located inside exposure room	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Interlock system installed (T.O. 33B-1-1, 6.8.7.3.4)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. Type of interlock system used:		Dual	
b. Tubehead is de-energized when interlock is tripped	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. X-ray tube cannot re-energize by closing interlock	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Interlock system tested at least every 6 months	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. ESO Switch within facility (T.O. 33B-1-1, 6.8.7.2.1.3)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. Type:		Push-In Red Button	
b. Number:		2	
c. Function properly	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Readily accessible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. ESO properly identified by labeling	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Suitable means to exit so person inside enclosure may exit without delay	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Warning signs properly posted (T.O. 33B-1-1, 6.8.7.2.1.3)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. Inside exposure room: <u>"Caution, High Radiation Area"</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Entrances to exposure room: <u>"Caution, High Radiation Area"</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Qualified radiographer present at control panel during exposures (T.O. 33B-1-1, 6.8.8.1)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. Safety Switch key removed when exposure is completed	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Search for personnel performed prior to activation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Comments:** At the time of the survey, the NDI lab was using the exposure room as storage for an installation-wide exercise. Per T.O. 33B-1-1, 6.8.7.2.1.3, "the shielded facility SHALL NOT be used for excessive storage."



## VI. SAFETY CHECK

**YES NO N/A**

### A. Operating Instructions

1. Radiological safety operating and emergency procedures approved by RSO (T.O. 33B-1-1, 6.8.2.2.4)

☒ ☐ ☐

a. Date of Review:

15 Jul 09

b. Emergency procedures specify:

i. Suspected overexposure contact info

☒ ☐ ☐

ii. Forms to be completed

☒ ☐ ☐

iii. Individual treatment locations

☒ ☐ ☐

iv. Approximating degree of exposure

☒ ☐ ☐

v. Direct reading dosimeters/TLDs

☒ ☐ ☐

2. Base RSO provided ALARA training (T.O. 33B-1-1, 6.8.2.1)

☒ ☐ ☐

Date of Training:

4 Jan 12, 8 Jan 12, 4 Mar 12

3. Ensure personnel are removed during exposures

☒ ☐ ☐

4. Survey meter used during entries into controlled areas after exposure

☒ ☐ ☐

5. Exposures assessed in controlled/uncontrolled areas (T.O. 33B-1-1, 6.8.5.7.5.3)

☒ ☐ ☐

6. Written reports filed with appropriate agencies (T.O. 33B-1-1, 6.8.5.7.5.1)

☒ ☐ ☐

7. Written reports contain specified/required elements (T.O. 33B-1-1, 6.8.5.7.5.3)

☒ ☐ ☐

### B. Radiographers:

1. Radiographers qualified through AF NDI Course (T.O. 33B-1-1, 6.8.3.1)

☒ ☐ ☐

2. Job/Qualifications documented in AF Form 623 (T.O. 33B-1-1, 6.8.3.2)

☒ ☐ ☐

3. Radiation Safety Monitor assistants used (T.O. 33B-1-1, 6.8.4.3)

☐ ☒ ☐

**Table 5. Personnel Listing**

Initial Training	Annual Training Date	Radiographer or Assistant	Last X-Ray Performed	Greater Than 3 Months?	X-Ray Monitored?
May 12	New	Radiographer	Tech School	No	Yes
Oct 10	Apr 12	Radiographer	Mar 12	No	Yes
Jan 09	Apr 12	Radiographer	Mar 12	No	Yes
Feb 79	Apr 12	Radiographer	Mar 12	No	Yes
Oct 01	Apr 12	Radiographer	Mar 12	No	Yes
Jun 89	Apr 12	Radiographer	Mar 12	No	Yes
Nov 10	Apr 12	Radiographer	Mar 12	No	Yes
Apr 12	New	Radiographer	Tech School	No	Yes
Feb 10	Apr 12	Radiographer	Mar 12	No	Yes
Nov 05	Apr 12	Radiographer	Mar 12	No	Yes

## VII. MEASUREMENTS AND DOSE ESTIMATES:

### A. Assumptions:

- General public dose limit is 2 mrem in any given hour and 100 mrem in a year (10 CFR 20.1301)
- Occupational dose limit is 5,000 mrem in a year (10 CFR 20.1201)
- The highest radiation measurement detected outside each barrier was used for a conservative estimate
- Various occupancy factors were used; see Attachment 3
- The measurement was rounded up to 3 significant digits or 0.001 mrem

B. Summary of Radiation Survey Measurements and Dose Estimates:

**Table 6. Survey Instruments**

Manufacturer	Model Number	Serial Number	Calibration Date
Fluke Biomedical	451P	6573	14 May 2012
Fluke Biomedical	451P	212	15 May 2012
Fluke Biomedical	451P	210	15 May 2012

**Table 7. Workload Summary Estimate**

Exposure Type	Technique			Estimated Workload	Exposures per Year	Exposure Duration <sup>1</sup> (hr)	Beam On – Time <sup>2</sup> (hr/yr)
	kVp	mA	Min <sup>3</sup>				
Average AFTO 125 Settings	146	5	8.82	3.5 per week	182	0.147	26.754

<sup>1</sup>Exposure Duration (hr) = (exposure time) / (60 minutes)

<sup>2</sup>Beam on-time = (exposures/yr) x (exposure duration in hours)

<sup>3</sup>Average time

**Table 8. Maximum Controlled and Uncontrolled Dose and Dose Rate Estimates**

Location	Area	Occupancy Factor	Highest Measurement (mR/hr)	Maximum Estimated Dose in an hour <sup>1</sup> (mrem)	Maximum Estimated Dose in a year <sup>2</sup> (mrem)
South Wall / Sliding Door Bottom Opening	Uncontrolled	0.025	0.707	0.104	0.473
West Wall / 5 ft	Uncontrolled	0.025	0.003	0.001	0.002
Rooftop above Tubehead	Controlled	0.025	22.793	3.351	15.245
East Wall (center) / 1 ft	Controlled	1	0.035	0.005	0.936
North Wall (Dark Room) / 5 ft	Controlled	1	0.005	0.001	0.134
North Wall (Entrance) / Right Center	Controlled	1	1.093	0.161	29.242

<sup>1</sup>Dose estimate for 1 hr = (highest measurement for location in mR/hr) x (1 hr beam-on time)

<sup>2</sup>Annual dose estimate = (highest measurement for location in mR/hr) x (occupancy factor) x (total beam on-time/yr in hr)

**Comments:** See Attachment 3 for additional survey measurements. One reading resulted in an exposure greater than 2 mrem in an hour; however, it was located on the rooftop above the exposure room. Since this area is controlled by NDI personnel and appropriate warning signs are posted on the rooftop, the risk of personnel being inadvertently exposed is minimal.

## VIII. CONCLUSION:

A. **Unrestricted Area Evaluation:** The maximum annual estimated dose in uncontrolled areas outside of the exposure room of Bldg 180 is 0.473 mrem/yr, and the maximum hourly estimated dose is 0.104 mrem/hr. This was taken at the bottom opening of the south sliding door. Exposure levels taken at the same location approximately 5 feet above the ground were far lower than this reading. Note that the estimated exposure dose is less than both the general public limit of 100 mrem/yr and the occupational limit of 5 rem/yr.

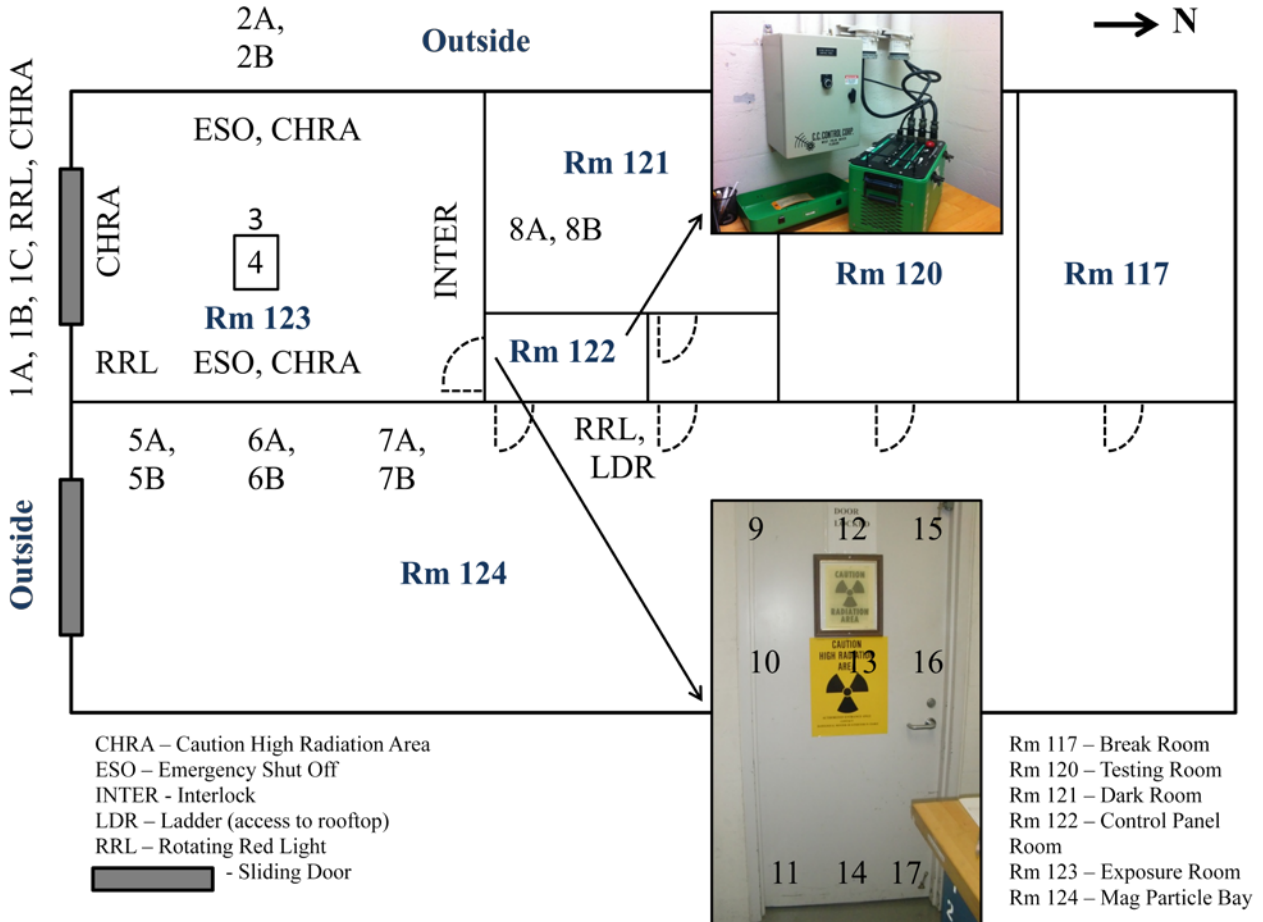
### B. Classification:










☒ **Shielded Installation:** A facility designed with sufficient shielding to meet exposure limit requirements. The Air Force describes a shielded installation as any enclosed radiographic facility designed to limit exposures on the outside of the facility to less than 2 mrem (0.02 mSv) in any 1 hour and less than 100 mrem (1 mSv) in a year, above background. The shielding design incorporates the energy of the x-ray or gamma ray source to be used, as well as the expected workload, use factors, and occupancy factors of installation. Occupancy factor SHALL be considered only for the 100 mrem (1 mSv) in a year limit.

☐ **Unshielded Installation:** An installation SHALL be classified as “unshielded” if due to operational requirements it cannot be provided with the inherent degree of protection specified for either Army “protective” or “enclosed” or Air Force shielded installations. Such installations include fenced or “roped-off” areas located either in the open or inside buildings such as hangar bays.

## ATTACHMENT 2

### DIAGRAM OF BLDG 180 w/ SURVEY LOCATIONS



		
<b>Exposure Room – South View</b>	<b>Exposure Room – West View</b>	<b>Rooftop – Warning Light</b>
		
<b>Exposure Room – North View</b>	<b>Exposure Room – East View</b>	<b>North Wall – Dark Room</b>
		
<b>West Wall</b>	<b>South Wall</b>	<b>East Wall – Mag Particle Bay</b>

# ATTACHMENT 3

## SURVEY MEASUREMENTS AND DOSE ESTIMATES

Diagram Location	Description	451P Serial Number	451P Bkg Reading (mR/hr)	Area	Highest Reading (mR/hr)	Occupancy Factor	Max Estimated 1 hr Dose <sup>1</sup> (mRem)	Max Estimated 1 yr Dose <sup>2</sup> (mRem)	Exceeds 2 mrem in any 1 hr or 100 mrem/yr
1A	Sliding Door / 5 ft	212	0.003	U	0.003	0.025	0.001	0.002	No
1B	Sliding Door / Bottom Opening	212	0.003	U	0.707	0.025	0.104	0.473	No
1C	Sliding Door / Crease Opening 6 ft	212	0.003	U	0.357	0.025	0.053	0.239	No
2A	West Wall / 5 ft	212	0.003	U	0.003	0.025	0.001	0.002	No
2B	West Wall / 1 ft	212	0.003	U	0.003	0.025	0.001	0.002	No
3	1 Meter from Tubehead	6573	0.007	C	4,919.993	0	723.239	0	No
4	Rooftop above Tubehead	6573	0.007	C	22.793	0.025	3.351	15.245	Yes
5A	East Wall (left) / 5 ft	210	0.020	C	0.028	1	0.041	0.749	No
5B	East Wall (left) / 1 ft	210	0.020	C	0	1	0	0	No
6A	East Wall (center) / 5 ft	210	0.020	C	0.005	1	0.001	0.134	No
6B	East Wall (center) / 1 ft	210	0.020	C	0.035	1	0.005	0.936	No
7A	East Wall (right) / 5 ft	210	0.020	C	0.030	1	0.004	0.803	No
7B	East Wall (right) / 1 ft	210	0.020	C	0	1	0	0	No
8A	North Wall (Dark Rm) / 5 ft	6573	0.007	C	0.005	1	0.001	0.134	No
8B	North Wall (Dark Rm) / 1 ft	6573	0.007	C	0.005	1	0.001	0.134	No
9	Entrance / Left Top	6573	0.007	C	0.203	1	0.030	5.431	No
10	Entrance / Left Center	6573	0.007	C	0.053	1	0.008	1.418	No
11	Entrance / Left Bottom	6573	0.007	C	0.493	1	0.073	13.190	No
12	Entrance / Top Center	6573	0.007	C	0.293	1	0.043	7.839	No
13	Entrance / Center	6573	0.007	C	0.103	1	0.015	2.756	No
14	Entrance / Bottom Center	6573	0.007	C	1.093	1	0.161	29.242	No
15	Entrance / Right Top	6573	0.007	C	0.133	1	0.020	3.558	No
16	Entrance / Right Center	6573	0.007	C	0.143	1	0.021	3.826	No
17	Entrance / Right Bottom	6573	0.007	C	0.893	1	0.131	23.891	No

C: Controlled area is an area controlled by the NDI Section and where workers have completed ALARA training.

U: Uncontrolled area includes area not controlled by the NDI Section and where workers have not received ALARA training.

<sup>1</sup>Dose estimate for 1 hr = (highest measurement for location in mR/hr)\*(1hr beam on time)

<sup>2</sup>Annual dose estimate = (highest measurement for location in mR/hr)\*(occupancy factor)\*(total estimated beam on time/yr in hours)

05684

## AIR FORCE PRIMARY STANDARDS LABORATORY

## CERTIFICATE OF CALIBRATION

Report Number: 121320030

Department: Photonics/Nucleonics

Date of Issue: 20120515

**Calibration Item:**

Manufacturer: INOVISION

Model/Part No.: 451P SERIES

Equipment Type: ION CHAMBER SURVEY METER

Serial Number: 0000000210

ID Number: F264452

**Equipment Submitted by:**

88 MSG/LGRMD

5060 PEARSON ROAD

WRIGHT PATTERSON AFB, OH, 45433-5517

**Item Condition:**

As Received: IN-TOLERANCE

The measured values of all parameters tested or calibrated were found to be within specification limits.

As Returned: IN-TOLERANCE

Item was calibrated and returned in-tolerance. This includes TO directed limitations.

**Room Ambient Conditions:**

Temperature: 72 °F

Relative Humidity: 45 %

Barometric Pressure: N/A

**Remarks:**

**Traceability:** Measurement standards and test equipment used are traceable to the International System of Units (SI) through the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities; or to other National Metrology Institutes (NMI); or have been derived from accepted values of natural physical constants; or mutual consent standards; or have been derived by the ratio or reciprocity type measurement techniques.

**General Conditions:**

1. The standards and calibration program of the AFPSL, as operated by The Bionetics Corporation, Newark Metrology Operations, complies with the requirements of the current version of ISO/IEC 17025 on the date of calibration.
2. This report may not be reproduced, except in full, without written approval of The Bionetics Corporation, Newark Metrology Operations.

**Calibrated By:**

Curtis A. Brissette Metrology Technician

**Approved By:**

Donald M. Hayes Lead Metrology Technician



Phone: (740) 788-5451

E-mail: Curtis.Brissette.ctr@afmetcal.af.mil

Phone: (740) 788-5451

E-mail: Don.Hayes.ctr@afmetcal.af.mil



813 Irving-Wick Drive West, Heath, Ohio 43056-6118

TEL: (740) 788-5400

FAX: (740) 788-5404

Report Number: 121320030  
Date of Issue: 20120515  
Model/Part No.: 451P SERIES  
Serial Number: 0000000210

## Procedures and Equipment Used

### PROCEDURES

Procedure  
33K7-4-93-1

Date  
30 Nov 2003

### EQUIPMENT

Nomenclature  
CESIUM-137 STANDARD

Model/Part No.  
81-10

ID No.  
P71064

NIST Report No.  
N/A

Cal Due Date  
20130602

The reported value(s) and uncertainties resulting from the measurement process are:

### Report of Measurement

Range mR/hr	Applied mR/hr	T.I. Reading mR/hr
0 - 0.5	0.4	0.390
0 - 5	1.0	1.0
0 - 5	4.0	4.07
0 - 50	10.0	9.9
0 - 50	40.0	38.0
0 - 500	100	100
0 - 500	400	391
R/hr	R/hr	R/hr
0 - 5	1.0	0.94
0 - 5	4.0	3.86

- The instrument calibration results are accurate to within  $\pm 10\%$  of reading between 10 and 100% full scale on any range, exclusive of energy response.



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05687

## AIR FORCE PRIMARY STANDARDS LABORATORY

## CERTIFICATE OF CALIBRATION

Report Number: 121320033

Department: Photonics/Nucleonics

Date of Issue: 20120515

**Calibration Item:**

Manufacturer: INOVISION

Model/Part No.: 451P SERIES

Equipment Type: ION CHAMBER SURVEY METER

Serial Number: 0000000212

ID Number: F264450

**Equipment Submitted by:**

88 MSG/LGRMD

5060 PEARSON ROAD

WRIGHT PATTERSON AFB, OH, 45433-5517

**Item Condition:**

As Received: IN-TOLERANCE

The measured values of all parameters tested or calibrated were found to be within specification limits.

As Returned: IN-TOLERANCE

Item was calibrated and returned in-tolerance. This includes TO directed limitations.

**Room Ambient Conditions:**

Temperature: 72 °F

Relative Humidity: 45 %

Barometric Pressure: N/A

**Remarks:**

**Traceability:** Measurement standards and test equipment used are traceable to the International System of Units (SI) through the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities; or to other National Metrology Institutes (NMI); or have been derived from accepted values of natural physical constants; or mutual consent standards; or have been derived by the ratio or reciprocity type measurement techniques.

**General Conditions:**

1. The standards and calibration program of the AFPSL, as operated by The Bionetics Corporation, Newark Metrology Operations, complies with the requirements of the current version of ISO/IEC 17025 on the date of calibration.
2. This report may not be reproduced, except in full, without written approval of The Bionetics Corporation, Newark Metrology Operations.

**Calibrated By:**

Curtis A. Brissette Metrology Technician

**Approved By:**

Donald M. Hayes Lead Metrology Technician



Phone: (740) 788-5451

E-mail: Curtis.Brissette.ctr@afmetcal.af.mil

Phone: (740) 788-5451

E-mail: Don.Hayes.ctr@afmetcal.af.mil



813 Irving-Wick Drive West, Heath, Ohio 43056-6118

TEL: (740) 788-5400

FAX: (740) 788-5404

Report Number: 121320033  
Date of Issue: 20120515  
Model/Part No.: 451P SERIES  
Serial Number: 0000000212

## Procedures and Equipment Used

### PROCEDURES

Procedure  
33K7-4-93-1

Date  
30 Nov 2003

### EQUIPMENT

Nomenclature  
CESIUM-137 STANDARD

Model/Part No.  
81-10

ID No.  
P71064

NIST Report No.  
N/A

Cal Due Date  
20130602

The reported value(s) and uncertainties resulting from the measurement process are:

### Report of Measurement

Range mR/hr	Applied mR/hr	T.I. Reading mR/hr
0 - 0.5	0.4	0.41
0 - 5	1.0	0.94
0 - 5	4.0	3.79
0 - 50	10.0	9.9
0 - 50	40.0	38.6
0 - 500	100	99
0 - 500	400	391
R/hr	R/hr	R/hr
0 - 5	1.0	0.95
0 - 5	4.0	4.25

- The instrument calibration results are accurate to within  $\pm 10\%$  of reading between 10 and 100% full scale on any range, exclusive of energy response.



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## AIR FORCE PRIMARY STANDARDS LABORATORY

## CERTIFICATE OF CALIBRATION

Report Number: 121320032

Department: Photonics/Nucleonics

Date of Issue: 20120514

**Calibration Item:**

Manufacturer: INOVISION

Model/Part No.: 451P SERIES

Equipment Type: ION CHAMBER SURVEY METER

Serial Number: 0000006573

ID Number: F264806

**Equipment Submitted by:**

88 MSG/LGRMD

5060 PEARSON ROAD

WRIGHT PATTERSON AFB, OH, 45433-5517

**Item Condition:**

As Received: UNKNOWN or Not applicable

The item was not calibrated by the PMEL and/or the calibration condition as received can NOT be determined

As Returned: IN-TOLERANCE

Item was calibrated and returned in-tolerance. This includes TO directed limitations.

**Room Ambient Conditions:**

Temperature: 73 °F

Relative Humidity: 47 %

Barometric Pressure: N/A

**Remarks:**

**Traceability:** Measurement standards and test equipment used are traceable to the International System of Units (SI) through the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities; or to other National Metrology Institutes (NMI); or have been derived from accepted values of natural physical constants; or mutual consent standards; or have been derived by the ratio or reciprocity type measurement techniques.

**General Conditions:**

1. The standards and calibration program of the AFPSL, as operated by The Bionetics Corporation, Newark Metrology Operations, complies with the requirements of the current version of ISO/IEC 17025 on the date of calibration.
2. This report may not be reproduced, except in full, without written approval of The Bionetics Corporation, Newark Metrology Operations.

**Calibrated By:**

Michael Harmon Metrology Technician

**Approved By:**

Donald M. Hayes Lead Metrology Technician



Phone: (740) 788-5451

E-mail: Michael.Harmon.ctr@afmetcal.af.mil

Phone: (740) 788-5451

E-mail: Don.Hayes.ctr@afmetcal.af.mil



813 Irving-Wick Drive West, Heath, Ohio 43056-6118

TEL: (740) 788-5400

FAX: (740) 788-5404

Report Number: 121320032  
Date of Issue: 20120514  
Model/Part No.: 451P SERIES  
Serial Number: 0000006573

## Procedures and Equipment Used

### PROCEDURES

Procedure  
33K7-4-93-1

Date  
30 Nov 2003

### EQUIPMENT

Nomenclature  
CESIUM-137 STANDARD

Model/Part No.  
81-10

ID No.  
P71063

NIST Report No.  
N/A

Cal Due Date  
20120608

The reported value(s) and uncertainties resulting from the measurement process are:

### Report of Measurement

Range mR/hr	Applied mR/hr	T.I. Reading mR/hr
0 - 0.5	0.4	0.404
0 - 5	1.0	0.98
0 - 5	4.0	3.97
0 - 50	10.0	10.1
0 - 50	40.0	39.7
0 - 500	100	98
0 - 500	400	386
R/hr	R/hr	R/hr
0 - 5	1.0	0.96
0 - 5	4.0	4.17

- The instrument calibration results are accurate to within  $\pm 10\%$  of reading between 10 and 100% full scale on any range, exclusive of energy response.



813 Irving-Wick Drive West, Heath, Ohio 43056-6118 TEL: (740) 788-5400 FAX: (740) 788-5404



**DEPARTMENT OF THE AIR FORCE**  
**HEADQUARTERS UNITED STATES AIR FORCE**  
**WASHINGTON DC**

7 May 2004

MEMORANDUM FOR AFRL/MLS-OL

FROM: AFMSA/SGPR  
 110 Luke Avenue, Room 405  
 Bolling AFB DC 20032-7050

SUBJECT: Lorad Laser Pointer Device Requirements

We recently received an inquiry from an Installation Radiation Safety Officer (RSO) concerning the use and occupational health requirements of the Lorad Class IIIa Laser Pointer as outlined in Technical Order 33B3-3-31-11, *LPX Constant Potential Industrial X-Ray System*. We offer the following suggestions to address occupational health concerns that are not addressed in the T.O. Please coordinate with the Air Force Institute for Operational Health, Radiation Surveillance Division (AFIOH/SDR) to ensure T.O. 33B3-3-31-11 and T.O. 33B-1-1, *Non-Destructive Inspection Methods* are updated.

AFIOH/SDR calculated a 35-meter (115-feet) nominal ocular hazard distance (NOHD) for the Lorad Class IIIa Laser Pointer (P/N: 3-000A-0792, NSN: 5860-01-378-6472). The NOHD is the straight-line distance from where laser radiation is emitted; the area within this distance is where eye damage has the potential to occur. Typically, laser use within the NOHD requires all personnel to wear laser eye protection (LEP), however LEP use with Class IIIa lasers is not required if the hazards can be controlled via well-defined standard operating procedures. Although LEP use is optional, operators must treat the Lorad Laser Pointer as a dangerous tool and not direct the laser beam towards any other person.

The Lorad Class IIIa Laser Pointer is considered a surveying, leveling or alignment laser product; it is manufactured and distributed per Food and Drug Administration requirements, 21 CFR 1040.11(b). Air Force laser use must comply with Air Force Occupational Safety and Health (AFOSH) Standard 48-139, *Laser Radiation Protection Program* requirements to protect laser users and bystanders from potentially harmful laser radiation. Unit commanders must appoint either a unit safety officer (USO) or a laser safety officer (LSO) per AFOSH 48-139, para. 1.11.4. In conjunction with the Installation RSO, the USO/LSO will assist the commander in implementing policies to enforce AFOSH 48-139 such as ensuring fellow workers follow laser safety procedures, and ensuring all personnel who work with lasers receive initial and annual laser training. Laser safety training should be provided to personnel, who work with or around lasers, in accordance with AFOSH 48-139, para. 2.4. Typical laser safety training topics are found in American National Standards Institute for the Safe Use of Lasers (ANSI Z136.1.), Appendix D6.2. Laser warning area signs are not required, however they are recommended per ANSI Z136.1, para. 4.3.9 since the laser beam can travel beyond the radiographic inspection area. Under no circumstances should the Lorad Class IIIa Laser Pointer be directed above the horizon near the flightline, as this may be dangerous to flight operations. Medical surveillance is not required for Class IIIa lasers per ANSI Z136.1, para. 6.1. Incidents involving a suspected laser radiation exposure must follow the procedures found in AFOSH 48-139, para. 2.6. Ensure AFIOH/SDR coordinates subsequent updates to T.O. 33B-1-1 and 33B3-3-31-11.

If you have any questions, please contact me at DSN 297-4309 or E-Mail at [craig.refosco@pentagon.af.mil](mailto:craig.refosco@pentagon.af.mil).

*Craig A Refosco*

CRAIG A. REFOSCO, Maj, USAF, BSC  
 Health Physicist  
 Radiation Protection Division  
 USAF Radioisotope Committee Secretariat  
 Air Force Medical Support Agency  
 Office of the Surgeon General

cc:  
 AFIOH/SDR  
 AFMSA/SGPR

## ATTACHMENT 6

**Laser Report**  
**AFRL 711HPW/RHDO 2.5.3.64**  
**LHAZ Plugin 5.2.3.2**  
**LTMC Version 3.2.2.7 / Adapter 3.1.0.19**  
**Tuesday, July 10, 2012**

**Laser Name:** Lorad LPX-160 pointer

**Laser Parameters:**

<b>Wavelength:</b>	670 nm
<b>Output Mode:</b>	ContinuousWave
<b>Average Power:</b>	4.2 mW
<b>Beam Profile:</b>	Elliptical
<b>Beam Distribution:</b>	Gaussian
<b>Beam Divergence:</b>	0.2 mrad X 0.7 mrad
<b>Beam Waist Diameter:</b>	0.92 mm X 3.25 mm
<b>Beam Waist Range:</b>	0 X 0

**MPE Computations:**

<b>Exposure Duration:</b>	0.25 s
<b>Exposure Range:</b>	10 cm
<b>MPE (Eye):</b>	2.598e-003 W/cm <sup>2</sup>
<b>Limiting Aperture (Eye):</b>	0.7 cm
<b>Class 1 AEL (Eye):</b>	1.000e-003 W
<b>Limiting Aperture (Skin):</b>	0.35 cm
<b>MPE (Skin):</b>	2.000e-001 W/cm <sup>2</sup>

Lower exposure MPE values are required for visible wavelength lasers when the eye is immobilized or has a large pupil such as health care with ophthalmic instruments or in research situations. See ANSI Z136.1, Section 8.3.

**Classification:** Class 3R

**Description:**

Part number comes up as Coherent laser. Assumed to be VLM3 -5 (4.2 mW at 670 nm). This is based off the AF part number (P/N: 3-000A-0792, NSN 5890-01-378-6472) coming back as a Coherent laser.

**Hazard Distances and OD Requirements:**

<b>Ocular</b> (10 cm, Unaided Viewing, Existing OD = 0)	
<b>Exposure Duration:</b>	0.25 s
<b>NOHD:</b>	33 m
<b>At Viewing Distance:</b> 10 cm	
<b>Maximum OD:</b>	0.7
<b>At Range OD:</b>	0.7

**Skin** (10 cm, Existing OD = 0)

**Exposure Duration:** 600 s

**NSHD:** 0 m

**At Exposure Distance:** 10 cm

**Maximum OD:** 0.0

**At Range OD:** 0.0

**Diffuse Reflection Hazard Analysis:**

**Laser to Target Range:** 1 m

**Target Reflectance:** 100.00%

**Viewing Angle:** 0 deg

**Ocular Hazards**

**Exposure Duration:** 600 s

**NHZ:** 0.0 m

**At Viewing Distance:** 1 m

**OD Required:** 0.0

**Skin**

**Exposure Duration:** 600 s

**NHZ (Skin):** 0.0 m

**At Exposure Distance:** 1 m

**OD Required:** 0.0

**Viewing Conditions:**

**Atm. Attenuation Coeff:** 0 cm<sup>-1</sup> (1/cm)

**Aided Viewing Used:** False

**Optics Transmittance:** N/A

**Optics Objective Diam:** N/A

**Optics Exit Diam:** N/A